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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

MISSOURI - MUSSELSHELL BASIN
DEADMAN'S BASIN DAMS AND RESERVOIR
WHEATLAND COUNTY, MONTANA
MT-11
MT-522

PREPARED FOR:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
(OWNER)

DEADMAN'S BASIN WATER USERS ASSOCIATION
(OPERATOR)

PREPARED BY:
HOSKINS - WESTERN - SONDEREGGER, INC.

APRIL, 1981

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EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers and with representation from the Owner (State of Montana Department of Natural Resources and Conservation) and the Operator (Deadman's Basin Water User's Association), Hoskins-Western-Sonderegger, Inc. (HWS) inspected the dam and the dike at Deadman's Basin Reservoir on 8 May 1979 under the authority of Public Law 92-367. Deadman's Basin Reservoir is located in Wheatland County, Montana, approximately 22 miles east of Harlowton.

This report was compiled from information obtained during an on-site inspection, review of construction plans and the Owner's records, and analysis of available hydrologic information. Findings were compared to engineering criteria currently accepted by most private and public agencies engaged in dam design, construction, and operation.

PRINCIPAL FINDINGS AND EVALUATION

Deadman's Basin Reservoir is primarily used for off-channel storage of irrigation water diverted from the Musselshell River. It is also used for recreation. Deadman's Basin Reservoir is formed in a natural basin by a 60-foot high main dam (MT-11), containing the outlet works, and by a long dike (MT-522). The reservoir has a natural drainage area of approximately 7.3 square miles, a normal surface area of about 2,120 acres, and a normal storage of approximately 76,820 acre-feet at a pool elevation of 3921.0 feet. The reservoir stores about 100,000 acre-feet when filled to the minimum crest elevation of the embankment (3931.7 feet).

Downstream features which could be affected by a sudden failure of either dam include three inhabited dwellings; the Chicago, Milwaukee, St. Paul and Pacific Railroad; U.S. Highway 12; and the town of Ryegate. In accordance with the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the project is classified as being of large size and as having a high (Category I) downstream hazard potential.

Inspection criteria (Ref. 1) recommend that the above-described project be capable of safely handling the full probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. An estimated PMF was developed for the 7.3-square-mile drainage basin during the dam safety analysis. This estimated PMF, resulting from a 72-hour storm, has a volume of approximately 11,270 acre-feet.

For this analysis the PMF was assumed to begin with the reservoir at the normal operating pool elevation, 3921.0 feet (10.7 feet below the main dam's minimum crest elevation and 2 feet below the grill forming the operating level in the gate tower). Approximately 23,180 acre-feet of storage is available between the normal operating pool elevation and the minimum crest elevation of the embankment. Under these conditions the PMF would cause the reservoir level to rise approximately 5.5 feet, assuming that the outlet was closed. This rise in reservoir level could cause the operating controls

to become partially submerged and possibly inoperable. The absence of any form of spillway would then prevent the reservoir level from being lowered. Although the project will handle the PMF under these conditions, serious operating difficulties could be encountered. The reservoir may not be able to handle the PMF should operational procedures allow the reservoir level to rise much above the normal operating pool elevation of 3921.0 feet.

During the visual inspection, seepage was noted at the base of the left abutment trough and above the conduit outlet at the main dam. No seepage or evidence of seepage was found in or below the dike. No piezometers are installed to measure water levels in the embankments. The dike has no internal drain. The main dam may contain an internal drain, but if it does, all traces of the drain were covered during the raising of the embankment in 1958. The main dam has a large bulge on the downstream face which may be the constructed configuration or may be caused by frost creep or by a generalized embankment movement. The outlet conduit, downstream from the control gates, contains frequent transverse cracks. These cracks leak water into the conduit during low conduit flows and can be assumed to allow water to escape into the embankment under pressure when the conduit flows full. Such leakage from the conduit could cause internal erosion, ultimately leading to failure of the dam.

Conditions described in this report suggest that the downstream face of the main dam may not conform to the recommended guidelines (Ref. 1) with respect to slope stability. Sufficient information is not currently available, however, for a complete evaluation of the stability of either embankment.

PRINCIPAL RECOMMENDATIONS

A downstream warning plan, for use in the event of possible embankment failure, needs to be developed and placed in operation immediately. It should be ascertained whether the gate controls can be operated during reservoir levels associated with the PMF. If necessary, a contingency plan of operation needs to be established for the specific case of a large flood causing the dam's operating controls to become inoperable due to submergence. Cracks in the outlet conduit should be sealed. Engineering studies, including field investigations, piezometer installation, and laboratory testing and analysis are necessary to determine whether the embankments require modification to provide adequate stability and seepage control.

Prior to performing engineering studies and remedial construction, the dam operator should coordinate the work with the Montana Department of Natural Resources and Conservation, Dam Safety Section, to insure compliance with all pertinent laws and regulations.

Stephen H. Nickel
Professional Engineer

PERTINENT DATA

1. GENERAL

Federal Identification No.	MT-11 (Main Dam), MT-522 (Dike)
Owner	State of Montana, Department of Natural Resources and Conservation
Operator	Deadman's Basin Water Users Association
Purpose	Irrigation, stock watering, recreation
Location	Wheatland County, Montana
Watershed	Tributary to Musselshell River
Downstream Hazard Potential	Category I (High)
U.S.G.S. Quadrangle	None
A.M.S. Map	Roundup, Montana

2. RESERVOIR

Surface Area at Normal Pool	2,120 acres
Storage at Normal Pool - Main Dam	76,820 acre-feet
Storage at Normal Pool - Dike	10,800 acre-feet
Total Storage (Min. Dam Crest)	100,000 acre-feet
Surcharge Storage	23,180 acre-feet
Drainage Area	7.3 square miles
Reservoir Water Surface Elev. (8 May 1979)	3915.9 feet (NGVD)
Normal Operating Pool Elev.	3921.0 feet (NGVD)

3. SPILLWAY

None

4. OUTLET WORKS (Main Dam)

Type	Controlled reinforced concrete conduit
Controls	2 - 60" x 60" cast iron slide gates with vertical access tower and control from dam crest
Size	7'-6" x 3'-9" rectangular base with 3'-9" semi-circular roof
Length	300 feet
Inlet Invert Elev.	3872.0 feet (NGVD)
Outlet Invert Elev.	3872.0 feet (NGVD)
Normal Tailwater Elev.	Unknown
Discharge Capacity (Min. Dam Crest)	1080 cfs

5. DAM	MAIN DAM (MT-11)	DIKE (MT-522)
Type	Earth	Earth
Maximum Height (Hydraulic)	60 feet	18 feet
Crest Length	1,490 feet	2,950 feet
Crest Elevation (Min.)	3931.7 feet (NGVD)	3932.8 feet (NGVD)
Crest Width	18 feet	15 feet
Upstream Slope	1V on 1.7H (above normal pool) 1V on 3H (below normal pool)	1V on 2H (above normal pool) 1V on 3H (below normal pool)
Downstream Slope	1V on 2.3H (above elevation 3897 feet) 1V on 1.8H (below elevation 3897 feet)	1V on 2H

CHAPTER 1

BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of Deadman's Basin Dams owned by the State of Montana, Department of Natural Resources and Conservation (DNRC).

The National Dam Inspection Act, Public Law 92-367 dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-federal dams throughout the United States. Pursuant to that authority, the Office of the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams," (Ref. 1) in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists, highly experienced in dam safety, from many federal and state agencies, professional engineering organizations and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary the guidelines outline a two-phased study procedure for investigating and evaluating existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam;
(2) based upon an evaluation of the available data and a visual inspection;
(3) performed to determine if any needed emergency measures and/or if additional studies, investigations and analyses are necessary or warranted; and
(4) not intended to include extensive explorations or analyses or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing, materials testing, hydraulic and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate

project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and neither action nor failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-federal interests.

1.1.3 Inspection

The findings and recommendations in this report were based on a visual inspection of the project on 8 May 1979, a brief engineering analysis, and an interview with representatives of the Owner. Construction drawings and inspection records obtained from the Montana Department of Natural Resources and Conservation were also used in the analysis. Inspection procedures and criteria were those established by the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1).

Personnel present during the inspection included:

Louis Boitano, Civil Engineer, Seattle District, Corps of Engineers;
Lawrence Tegg, State of Montana, Department of Natural Resources and Conservation;
Robert Clark, State of Montana, Department of Natural Resources and Conservation;
Lestley Fosty, Deadman's Basin Water Users Association;
Harold A. Eliasson, Deadman's Basin Water Users Association;
J. C. Jensen, Jr., Deadman's Basin Water Users Association; and
Marion Robinson, Operator

Hoskins-Western-Sonderegger, Inc. (HWS) personnel who participated in the field inspection and contributed to this report are:

Stephen Nickel, Geotechnical Engineer, Team Leader;
Richard Walker, Hydrologist/Hydraulics Engineer; and
E. L. Hohnstein, Civil Engineer, Dam Section Chief.

This report has been reviewed by the Montana DNRC and by the Deadman's Basin Water Users Association. Written comments from the DNRC are included in the Appendix of this report. The Deadman's Basin Water Users Association chose not to comment.

1.2 DESCRIPTION OF PROJECT

1.2.1 General

Deadman's Basin Reservoir is an off-channel irrigation storage impoundment for water diverted from the Musselshell River. The dam and reservoir are owned by the Montana Department of Natural Resources and Conservation and operated by the Deadman's Basin Water Users Association. The project is located in Sections 13, 22, 23, 24, 25, 26, 27 and 35, Township 7 N, Range 18 E, Wheatland County, Montana, approximately 22 miles east of Harlowton. The reservoir sits in a large natural basin. The natural storage of the basin was increased by the construction of two saddle dams on the southeast side of the basin. The north, or main, dam (MT-11) is approximately 60 feet high, and the south dam, or dike (MT-522), is approximately 18 feet high.

The supply canal inlet for flows diverted from the Musselshell River is located in the southwest corner of the reservoir. The reservoir is also supplied by several unnamed tributaries to the basin, which have a total drainage area of approximately 4.0 square miles. The normal pool elevation for the reservoir is 3921.0 feet. Surface area at this elevation is 2,120 acres, and storage is 76,820 acre-feet. The only outlet for the two embankments is a gated, reinforced concrete conduit in the main dam, which supplies flows for irrigation purposes.

Water released from the reservoir flows into two canals. Careless Creek Canal carries flow northeasterly into Careless Creek, a tributary of the Musselshell River. Barber Canal flows south from the reservoir and returns flow directly to the Musselshell River. Water from this project provides irrigation for approximately 20,000 acres of hay, corn, and pasture.

According to criteria in the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), this project is large in size. Based on a visual reconnaissance and engineering judgment, three inhabited dwellings, the Chicago, Milwaukee, St. Paul and Pacific Railroad, U.S. Highway 12, and the town of Ryegate (population 261) could be affected by a sudden breach of either embankment. In accordance with the recommended guidelines (Ref. 1), the project is, therefore, classified as having a high downstream hazard potential (Category 1).

1.2.2 Regional Geology

The drainage area of the Musselshell River is a region of basin and range complicated by thrust faulting. Before the late Cretaceous, this was an area of quiet basinal sedimentation. Pre-Cambrian, Paleozoic, and Mesozoic sedimentation produced sandstones, shales, and some limestones. During late Cretaceous and Tertiary times, the nearby mountain ranges were formed. During this mountain-building era, the basinal sediments were formed into a dome containing smaller anticlines and synclines. The most prominent of these are the Little Belt Mountains and the Snowy Mountains. After the mountain building, erosional debris from the mountains was swept down by rivers and streams to cover the earlier Cretaceous sandstone and shales and form the Eocene Fort Union Formation, consisting of sandstone, shale, and bituminous coal.

Subsequent erosion of this domed basin has produced the present topography which shows a rim of Fort Union deposits with succeedingly older Cretaceous deposits toward the center of the present smaller basins. These Cretaceous deposits are predominantly the sandstones and shales of the Livingston Formation. The oldest formation exposed in the basins is the Colorado Shale.

1.2.3 Seismicity

Deadman's Basin lies on the border between Seismic Zones 1 and 2 as indicated by the Seismic Zone Map (Ref. 1). The seismic probability of Zone 2 is one of a potential for moderate damage, while that of Zone 1 is one of a potential for slight damage. The Zone boundaries are based on the known distribution of damaging earthquakes in the region.

No major faults have been mapped in the immediate vicinity of the project, although traces of minor faults can be inferred from aerial photographs and topographic maps. No active faults were found or inferred at the site of the dam. The closest faults identified on the Geologic Map of Montana lie 18 miles south of the project site.

Epicenters of local earthquakes significant enough to be reported in References 2 and 3 occur approximately along a line from 20 miles northwest of Helena to 25 miles north of Bozeman. The three largest reported earthquakes along this line have had intensities of VIII (Modified Mercalli). One of these earthquakes had its epicenter at a point 25 miles north of Bozeman (27 June 1925), while the other two occurred at Helena (18 October and 31 October 1935). Of these two epicentral areas, the former is 80 miles and the latter 140 miles from the reservoir. No reported earthquakes have occurred at distances of less than 80 miles from the reservoir.

1.2.4 Site Geology

The project site is within a topographic basin, formed by erosion of a small anticline which has an axis running roughly northeast-southwest. The Eagle Sandstone forms a rimrock to the west and north of the reservoir and can be seen steeply dipping immediately east and northeast of the main dam (see Photos 1, 2 and 3). The floor of the basin is cut into the Colorado Formation. The Colorado Formation is primarily shale, with siltstone and some sandstone. Natural drainage toward the southwest, along the anticline axis may have been blocked by glacial outwash, forcing accumulating water to seek the outlets now blocked by the embankments.

Sandstone forms the foundations for both abutments of the main dam and all of the dike. However, the highest part of the main dam may be founded on shale. Three to six feet of sandy soil may have originally been overlying the sandstone or shale in the foundations and abutments. The construction plans show an upstream cutoff trench approximately 10 feet deep (bottom width = 20 feet) for the main dam (Plate 4) and an upstream cutoff at least 5 feet deep (bottom width = 8 feet) for the reconstructed dike (Plate 7). It appears that these cutoffs were made to control seepage through the soil mantle.

1.2.5 Design and Construction History

The Deadman's Basin project was completed in 1941. The project had the backing of the Montana State Water Conservation Board (SWCB), the counties of Golden Valley, Wheatland, and Musselshell, and the Works Progress Administration. Design was by the SWCB and financing was from SWCB funds and through a loan from the Reconstruction Finance Corporation. Construction plans for the original design were obtained from the DNRC (Plates 4-6).

According to the construction plans, the original embankments (the main dam and three small dikes) were constructed of impervious fill, with a 2-foot thick layer of gravel and a 3-foot thick layer of riprap on the upstream faces. The type of soil used for the impervious fill is not known. In addition to the reinforced concrete irrigation outlet, an emergency spillway was planned at the right abutment of the main dam. This spillway, however, was never constructed. In 1958 the embankment crest elevation was raised 10 feet by adding material on the downstream side of the main dam and by incorporating the three existing dikes into one and raising the height to match the main dam. Construction plans for these modifications were obtained from the DNRC (Plate 7).

CHAPTER 2

INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Irrigation Outlet - Main Dam

The irrigation outlet, located in the main dam, is a reinforced concrete conduit, with a 7'-6" x 3'-9" rectangular base and a 3'-9" radius semi-circular roof. Total length of the conduit is 300 feet. Flows are regulated by two 60" x 60" cast iron slide gates located in the vertical access tower on the upstream side of the dam crest (Plates 5 and 6). The operating gate is normally operated by a stationary gasoline engine. It can also be operated manually. The emergency gate can be operated manually or by portable power equipment owned by the DNRC. The inside of the conduit and the control gates can be seen in Photographs 6 and 7.

Inspection of the irrigation conduit was made possible by closing the emergency gate and pumping out the outlet basin. The cast iron slide gates were in fairly good condition. Some pitting and rusting of the exposed surfaces was observed, and some leakage through the closed emergency gate was visible. Several vertical cracks extending from the floor on one side to the floor on the other side were observed in the walls and roof of the conduit. The largest crack, located approximately 50 feet from the outlet, was leaking clear water into the conduit at a rate of approximately 1/4 to 1/2 gallon per minute. Several of the cracks can be seen in Photo 6. The floor of the conduit did not appear to be cracked. The concrete outlet basin was in fairly good condition with some spalling in the basin floor. Some minor erosion and sloughing of the banks was evident around the walls of the outlet structure and in the outlet channel. Original construction plans (Plate 5) called for a flat-bottomed masonry outlet structure. The existing concrete outlet structure (Photo 8) has warped, streamlined wing walls and an energy-dissipating sill at the downstream end of the structure. The reinforced concrete intake structure and the conduit upstream of the access tower were under water and could not be inspected.

The original construction plans indicate that the Contractor had the option to build the central portion of the conduit by cut-and-cover methods or by tunneling. If tunneling was used, voids could have been left along the outside of the conduit. Such voids could promote piping along the conduit, especially when coupled with cracks in the conduit and sand embankment material. When the conduit flows full, water may be forced out of the conduit through the existing cracks,presenting the potential for a piping failure along the outside of the conduit. However, no evidence of this type of failure was visible.

The invert elevation of the conduit inlet and outlet is 3872.0 feet. This is 59.7 feet below the minimum crest elevation of the main dam and 60.8 feet below the minimum crest elevation of the dike. The capacity of the conduit at the minimum crest elevation of the main dam, based on full pipe flow conditions (Manning's "n" = 0.013) and assuming the control gates to

be fully opened, is 1080 cubic feet per second (cfs). The complete outlet discharge rating curve can be seen on Plate 9.

2.1.2 Freeboard

The vertical freeboard distance between the water surface and the minimum dam crest at the time of inspection was 15.8 feet for the main dam and 16.9 feet for the dike. Freeboard for the normal pool level (elevation 3921.0 feet) is 10.7 feet for the main dam and 11.8 feet for the dike.

The effective fetch distance for wind-generated waves is approximately 1.7 miles for the main dam and 1.8 miles for the dike. The total of wave run-up and wind set-up is approximately 6.8 feet for the main dam and 7.0 feet for the dike. The freeboard at normal pool level is, therefore, adequate to prevent wave overtopping at normal pool conditions (Ref. 4).

Reservoir routings indicate that the Probable Maximum Flood (PMF) will cause the reservoir to rise from the normal pool elevation of 3921.0 feet to elevation 3926.5 feet. Freeboard for the PMF, therefore, is 5.2 feet for the main dam and 6.3 feet for the dike.

2.2 HYDROLOGY

2.2.1 Climatology and Physiography

The climate of the area around Deadman's Basin is continental and characterized by a large daily and seasonal temperature range. Extreme variability of wintertime temperature results from the frequent occurrence of chinook winds. The summers are characterized by warm days with low humidity and cool nights. Winters are cold and highly variable in severity from year to year and within a given year.

Harlowton, located in the Musselshell River valley approximately 22 miles west of Deadman's Basin, is the nearest climatological station representative of the project site. The elevation of Harlowton is approximately 4200 feet. Precipitation and climatological data are available for approximately 90 and 70 years, respectively. Average annual precipitation at Harlowton is approximately 14 inches, and average annual snowfall is approximately 37 inches. Over 60 percent of the precipitation falls from March through August. Temperature extremes range from -50°F to 100°F, with the average expected date of the first freeze being September 7 and the average expected date of the last freeze being June 4 (Ref. 5 and 6).

The natural drainage area of Deadman's Basin Reservoir is approximately 7.3 square miles, of which approximately 3.3 square miles is reservoir. Three intermittent natural tributaries drain into the northwest side of the reservoir. The supply canal for flows diverted from the Musselshell River drains into the southwest side of the reservoir. Basin elevations range from the normal pool elevation of 3921.0 feet to approximately 4300 feet at the drainage divide. The vegetation of the area consists of rolling short grass plains with sparse pine tree cover on the upland slopes.

2.2.2 Reservoir Storage and Outlet Discharge

The reservoir has a surface area of approximately 2,120 acres and a storage of approximately 76,820 acre-feet at the normal pool elevation of 3921.0 feet. Approximately 23,180 acre-feet of storage is available between the normal pool and the minimum crest elevation of the main dam (3931.7 feet). The complete stage-area and stage-storage curves for the reservoir are shown on Plate 8. Discharge through the irrigation outlet is approximately 1,080 cfs at the minimum crest elevation, assuming that the control gates are fully open. The complete outlet discharge rating curve is shown on Plate 9.

2.2.3 Estimated Probable Maximum Flood

The Probable Maximum Flood (PMF) is defined as the flood expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. A Probable Maximum Precipitation (PMP) storm of 72-hour duration was applied to the basin. This storm was derived in the following manner: the 1-hour, 6-hour, and 24-hour PMP depths were estimated from National Weather Service Technical Paper 38 (Ref. 7), and the 48-hour and 72-hour PMP depths were taken as 110 percent and 115 percent of the 24-hour index PMP, respectively. All 6-hour increments from 0 to 72 hours are arranged in accordance with criteria in Weather Bureau Hydrometeorological Report No. 43 (Ref. 8). A constant soil loss rate of 0.06 inch/hour was applied throughout the 72-hour PMP storm (Refs. 9 and 10).

The resulting configuration of the 72-hour PMP storm is as follows. Total rainfal is 9.0 inches for the maximum hour, 14.5 inches for the maximum 6 hours, 19.0 inches for the maximum 24 hours, 20.9 inches for the maximum 48 hours, and 21.9 inches for the total 72 hours. Soil infiltration losses for the above periods are 0.06 inch, 0.36 inch, 1.44 inches, 2.88 inches, and 3.86 inches, respectively. Net runoff, therefore, for the above periods is 8.94 inches, 14.14 inches, 17.56 inches, 18.02 inches, and 18.04 inches, respectively. The above soil losses apply only to the watershed land area. Direct precipitation onto the reservoir was added in with no losses.

Inflow from the reservoir supply canal was also considered during the PMF. The capacity of the supply canal is listed as 600 cfs in a project description obtained from the DNRC (Ref. 11). The canal was assumed to flow at maximum capacity during the entire 72-hour PMP storm.

2.2.4 Flood Routing

The reservoir level at the beginning of the 72-hour PMP was assumed to be at the normal operating pool elevation of 3921.0 feet. The control gates for the irrigation outlet were assumed to be fully closed. The total volume of the 72-hour PMF is approximately 11,270 acre-feet with a peak flow rate of approximately 49,900 cfs. Given the above conditions, the reservoir level at the end of the 72-hour PMP storm would be 3926.5 feet. Deadman's Basin Reservoir will, therefore, hold the entire 72-hour PMF with 5.2 feet of freeboard to the minimum crest elevation of the main dam and 6.3 feet of freeboard to the minimum crest elevation of the dike. This allows a comfortable margin of safety for antecedent floods or for malfunction of the controls on canal inflow which could raise the reservoir above elevation

3921.0 feet prior to the PMF. Flood routings were made using the HEC-1 (Dam Safety Version) computer program (Ref. 12).

2.3 GEOTECHNICAL EVALUATION

2.3.1 Dam Embankments

Main Dam

The 60-foot-high main dam embankment is 1490 feet long and has a crest width of 18 feet. The upstream slope is 1 vertical (V) on 3 horizontal (H) and steepens near the normal pool elevation to 1V on 1.7H. The downstream slope is roughly 1V on 2.3H for the upper 35 feet; below that point the slope is approximately 1V on 1.8H. These slopes are only slightly different than those shown on the plans (Plate 7). The crest is fairly uniform, varying about 0.5 feet in elevation. Most of this variation can be attributed to water-retaining depressions which have been allowed to form in the roadway on the crest. The crest is approximately 1 foot lower than the plan elevation. No longitudinal or transverse cracks were found. The surface material on the downstream slope appears to have been disturbed, perhaps by frost creep, leaving a fluffy, hummocky texture. Rodent holes were found on all surfaces of the embankment.

The main dam was constructed to an initial height of 50 feet and was raised an additional 10 feet in 1958 by placing rock facing on the upstream side, impervious fill in the central portion, and semi-pervious fill on the downstream side of the original embankment (Plate 7). The nature of the impervious fill used in raising the dam is not known. The semi-pervious fill, as exposed on the downstream face, is a silty sand.

Plans for the original construction show a cutoff at the upstream toe, which was 10 feet deep at the maximum dam section with a 20-foot bottom width (Plate 4). The original construction plans also show a gravel filter blanket beneath the riprap (Plate 5). The 1958 plans show no filter under the riprap to be placed. However, the 1958 plans show the new riprap to be a minimum of eight feet thick horizontally and all of it to be above the normal pool elevation (Plate 7). There is no instrumentation in the main dam.

Dike

The 18-foot-high dike embankment southwest of the main dam is 2950 feet long and has a crest width of 15 feet. The upstream face is 1V on 3H below the normal pool elevation and 1V on 2H above. The downstream face is 1V on 2H. Riprap on the upstream face is five feet thick perpendicular to the slope. There is no granular filter or transition zone. The plans show that the three small original dikes were incorporated into the existing dike in 1958. A section through the dike is shown on Plate 7. A cutoff was included in the upstream portion of the reconstructed dike. The cutoff is a minimum of five feet deep with an 8-foot bottom width. Rodent holes were found on all surfaces of the embankment. There is no instrumentation in the dike.

2.3.2 Foundation Conditions, Seepage and Drainage

Main Dam

The main dam is founded on beds of alternating shales and sandstones which are dipping downstream at roughly 30 degrees. Seven borings were drilled along the dam centerline in 1967 to evaluate the condition of the embankment after a period of exceptionally high pool levels. Logs of these borings are provided in Appendix A. Boring locations are shown by original dam crest stationing (see profile, Plate 7, for stationing). Casings from these borings are still in place in the embankment, but they are filled with soil. The boring logs show considerable sandstone in the upper foundation. Most of the sandstone was carrying water. Boring 6, 100 feet left of the conduit, and boring 3, 150 feet right of the conduit, penetrated permeable strata under considerable head. Although the reservoir stage was not indicated on the borings, the measured pressure head for these two borings was within about 20 feet of the dam crest elevation.

Although the plans (Plate 4) show a pipe drain section, it is not known whether this was actually constructed, because no drain outlet could be found during the inspection. Conceivably, the drain and its outlet were covered during the 1958 work. At the time of the inspection the pool was being filled for summer irrigation use and was about seven feet below the normal pool elevation. However, there was slight seepage evident at the base of the left abutment contact. At the time of inspection, there was moisture along the downstream toe of the embankment, but its location was also where snow would have drifted and recently melted. There was seepage exiting at the conduit outlet headwall with a sufficient quantity of flow to keep the headwall wet (Photo 8).

Dike

The dike stands in a sandstone outcrop area and appears to be founded on several feet of sandy soil. It is not known whether the cutoff extends to sound rock.

At the time of the inspection, the reservoir level was below the base of the dike (Photo 11). Under these conditions no seepage was expected to be found. Also, no evidence of seepage exiting from the embankment or below the toe was found.

No drains are shown on the plans for the dike and none were found.

2.3.3 Stability.

No stability data is available for either embankment. To our knowledge there is no functional internal drainage provided in either the main dam or the dike, and the possibility exists for a high phreatic surface within the embankments or high uplift pressures in the foundation. Strength properties of the embankment materials are unknown, and, without additional data, we cannot evaluate the stability of either structure. However, the possibility exists that the embankments are only marginally stable.

2.4 PROJECT OPERATION AND MAINTENANCE

2.4.1 Embankments

Maintenance of the dam and dike is performed by the Deadman's Basin Water Users Association, as required. During the inspection it was noted that some of the maintenance procedures recommended in DNRC inspection reports (References 13 and 14) have not yet been performed, three or four years later. However, the project appears to have generally good maintenance.

2.4.2 Reservoir

The reservoir is filled each spring by flows diverted from the Musselshell River. The supply canal inlet for these flows is at the southwest corner of the reservoir. The only controls on supply canal inflow are located at the diversion headworks at the Musselshell River. The maximum capacity of the supply canal is 600 cfs. Wasteways located along the supply canal prevent it from flowing much above this capacity. Water is released from the reservoir as needed during the irrigation season. Inflow and outflow are measured by water stage recorders on all canals.

According to representatives of the owner, the normal operating pool elevation to which the operators attempt to fill the reservoir each spring is 3921.0 feet. This elevation is 2 feet below the grill which forms the floor at the operation level in the gate tower. Since there is no spillway, it is possible that a large antecedent flood, a malfunction of the controls on supply canal inflow, or operational procedures could cause the reservoir to rise above 3921.0 feet prior to the PMF. The reservoir level at the time of inspection (8 May 1979) was 3915.9 feet.

2.4.3 Warning Plan

There is no formal warning plan to warn downstream inhabitants or interests in the event of impending dam failure.

CHAPTER 3

FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of the Deadman's Basin Dams, supplemented by analysis of the project in terms of the recommended guidelines' performance standards, resulted in the following findings:

3.1.1 Size, Hazard Classification and Safety Evaluation

According to the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the Deadman's Basin project is classified as large size with high downstream hazard potential. The recommended spillway design flood (SDF) for this project is the full Probable Maximum Flood (PMF). The storage capacity of the reservoir is sufficient to handle the entire PMF without overtopping of the dam. The stability of the embankments is questionable under the condition of a very high pool elevation.

3.1.2 Embankment Dams

Main Dam

Wet soil at the base of the left abutment contact was noted as evidence of seepage at that location. Additional seepage was noted above the headwall and left wingwall of the conduit outlet. The seepage above the conduit outlet is significant in that it occurred when the reservoir elevation was 5.1 feet below the normal operating level. Observed seepage into the conduit amounted to perhaps one to two gallons per minute. A Montana DNRC inspection report (Ref. 14) indicates that the noted seepage areas all produce more water when the pool is at a higher elevation.

A visual inspection of the embankment revealed no longitudinal or transverse cracking. However, the surface material on the downstream slope appeared to have been disturbed, perhaps by frost creep, leaving a fluffy, hummocky texture. In addition, the change in slope on the downstream face may be an indication of instability. While the construction plans show the downstream slope as 1V on 2H, the measured slope (Station 4+50) is about 1V on 2.3H from the crest to an elevation of 3897 feet. Below that point, the slope is approximately 1V on 1.8H. The reason for this bulge could not be determined by visual inspection alone. Water-retaining depressions have been allowed to form in the roadway on the crest. These may be potentially dangerous to the stability of the dam as sources of saturation water. Rodent holes were found on all surfaces of the embankments. Water flowing through rodent holes could cause a rapid failure of the dam during a period of high pool elevation.

There is no instrumentation, such as piezometers, installed in the dam. However, the casings from the 1967 borings are in place. These casings could act as observation wells if they were properly cleaned out and capped. Data from these borings indicate the potential existence of uplift forces

with no means of relief. Current water level data from the casings would greatly aid the understanding of the embankment stability.

Based on experience with similar structures and materials, the main dam may not conform to the recommended guidelines on stability which require a safety factor of at least 1.50 for the condition of steady state seepage with the pool at the normal operating elevation (Ref. 1). However, there is insufficient information presently available for evaluation of stability.

Dike

As the reservoir level was 16.9 feet below the minimum dike crest elevation at the time of the inspection and the maximum dike height is 18 feet, no conclusion can be drawn about steady state seepage. No seepage was present, and there was no evidence to suggest that seepage occurred on a regular basis. Possible high phreatic levels in the dike embankment combined with the 1V on 2H downstream slope could result in marginal stability; however, sufficient information is not presently available for the evaluation of stability. Rodent holes were found on all surfaces of the embankment.

3.1.3 Outlet Works

Several vertical cracks were observed in the walls and roof of the reinforced concrete irrigation conduit. The largest crack, located approximately 50 feet upstream from the outlet end of the conduit was leaking water into the conduit at a rate of approximately 1/4 to 1/2 gallon per minute. With full flow conditions in the conduit, water could be forced out of the conduit through these cracks presenting the potential for a piping failure along the outside of the conduit.

The cast iron slide gates were in good condition. The concrete outlet basin was in good condition except for the floor, which showed some spalling. The intake structure and the conduit upstream of the access tower were under water and could not be inspected.

3.1.4 Reservoir Capacity

With the reservoir at the normal operating pool elevation of 3921.0 feet, the reservoir storage capacity is sufficient to contain the entire PMF with the control gates of the irrigation conduit fully closed. Since there is no spillway, however, operation of the reservoir is very important. The reservoir will be able to contain the entire PMF only if operational procedures prevent the reservoir level from rising much above the normal operating pool elevation of 3921.0 feet.

3.1.5 Operation and Maintenance

Operation and maintenance are performed by the Deadman's Basin Water Users Association. There is no written operation plan for the reservoir. Water is diverted to the reservoir from the Musselshell River and is released from the outlet as needed for irrigation. Consequently, the reservoir level fluctuates seasonally. A potential operation problem was noted in that it

is possible for the reservoir level to rise above the level of the outlet operating controls. This would make reservoir operation very difficult, since there is no spillway.

There is no formal maintenance plan for the dams, with maintenance performed on an as-needed basis. Several maintenance items currently need attention. These are detailed in paragraph 3.2.

There is no warning plan to alert downstream inhabitants in the event of impending dam failure.

3.2 Recommendations

1. Immediately develop, implement, and periodically test an emergency warning plan for use in the event of dam distress.

2. Inspect the downstream abutment contacts and toe areas of both embankments for seepage before, during, and following high-pool periods.

3. Seal all cracks in the outlet conduit.

4. Eliminate rodent populations on the embankments and repair existing rodent damage.

5. Regrade and, if necessary, regravel the crest to eliminate the small depressions capable of ponding water.

6. Ascertain whether the gate controls could be operated while submerged. If operation would be difficult or impossible, establish and implement a plan of operation allowing such operations.

7. Formalize an operation plan to prevent normal storage of water above elevation 3921.0 feet.

8. Conduct engineering studies to ascertain the stability of the embankments. Recommended studies, to be performed by an experienced geotechnical engineer, should include:

   - Sampling and testing of soils in the embankments and their foundation;

   - Installation, maintenance and evaluation of piezometers in the embankments, the abutments, and along the downstream toes, including cleaning out the casings remaining from the 1967 borings for use as observation wells;

   - An analysis of the embankments' stability according to the recommended guidelines (Ref. 1); and

   - An evaluation of observed seepage around the conduit outlet and elsewhere as noted.

9. In accordance with the results of the studies, modify the embankments as required to establish adequate factors of safety.

10. Develop and implement a periodic maintenance plan for the dams and appurtenant structures.

11. Continue all existing maintenance programs. Conduct periodic inspections at no more than 5-year intervals, including a geotechnical engineer knowledgeable in the design and construction of earth dams on the inspection team.

Prior to performing engineering studies and remedial construction, the dam operator should coordinate the work with the Montana DNRC, Dam Safety Office, to insure compliance with all pertinent laws and regulations.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C., Department of the Army, May 1975.

2. U.S. Department of Commerce, Earthquake History of the United States, Publication 41-1, Washington, D.C.

3. U.S. Geological Survey, Earthquake Information Bulletin, Washington, D.C., 1973-1978.

4. U.S. Army Corps of Engineers, Office of the Chief of Engineers, "Wave Run-Up and Wind Set-Up on Reservoir Embankments," Engineer Technical Letter No. 1110-2-221.

5. U.S. Department of Agriculture, Soil Conservation Service, "Average Annual Precipitation in Montana," Portland, OR, 1977.

6. Caprio, J. M., "Montana: Average Date of Freeze," Folders No. 81, 82, and 83, Montana Agricultural Experiment Station, Montana State College, Bozeman, Montana, March 1965.

7. U.S. Department of Commerce, Weather Bureau, Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian, Technical Paper No. 38, U.S. Government Printing Office, Washington, D.C., 1960.

8. U.S. Department of Commerce, Environmental Science Services Administration, Weather Bureau, Probable Maximum Precipitation, Northwest States, Hydrometeorological Report No. 43, Washington, D.C., November 1966.

9. Nunns, F. K., Soil Survey: The Upper Musselshell Valley Area Montana, U.S. Department of Agriculture, Bureau of Plant Industry, Soils and Agricultural Engineering, in Cooperation with the Montana Agricultural Experiment Station, Series 1939, No. 1, Issued November 1943.

10. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "Unit Hydrograph Concepts and Calculations," Unpublished notes distributed at North Pacific Division Workshop on Phase I Dam Safety Investigations held Seattle, Washington, November 1978.

11. "Deadman's Basin," Project description obtained from State of Montana, Department of Natural Resources and Conservation.

12. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Users Manual for Dam Safety Investigations, Davis, California, September 1978.

13. State of Montana, Department of Natural Resources and Conservation, Water Resources Division, Engineering Bureau, "Dam Safety Inspections - Deadman's Basin - Project No. 092," April 29, 1975.

14. State of Montana, Department of Natural Resources and Conservation, Water Resources Division, Engineering Bureau, "Dam Safety Inspection - Deadman's Basin - Project 092," May 25, 1976.

(PHOTO 1) Overview, Deadman's Basin Reservoir.

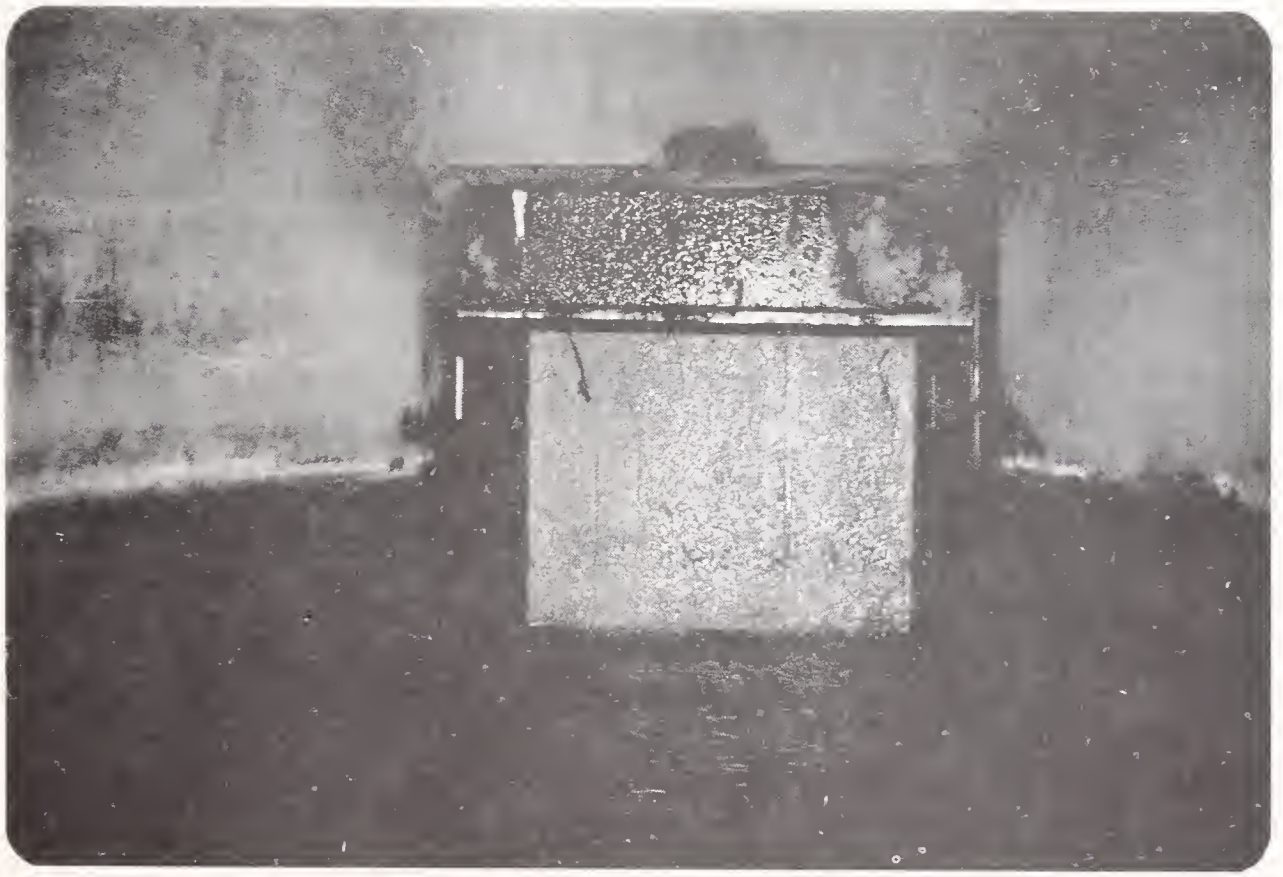
(PHOTO 2) Main Dam, Upstream Face from Right Abutment.

(PHOTO 3) Main Dam, Crest at Right Abutment.

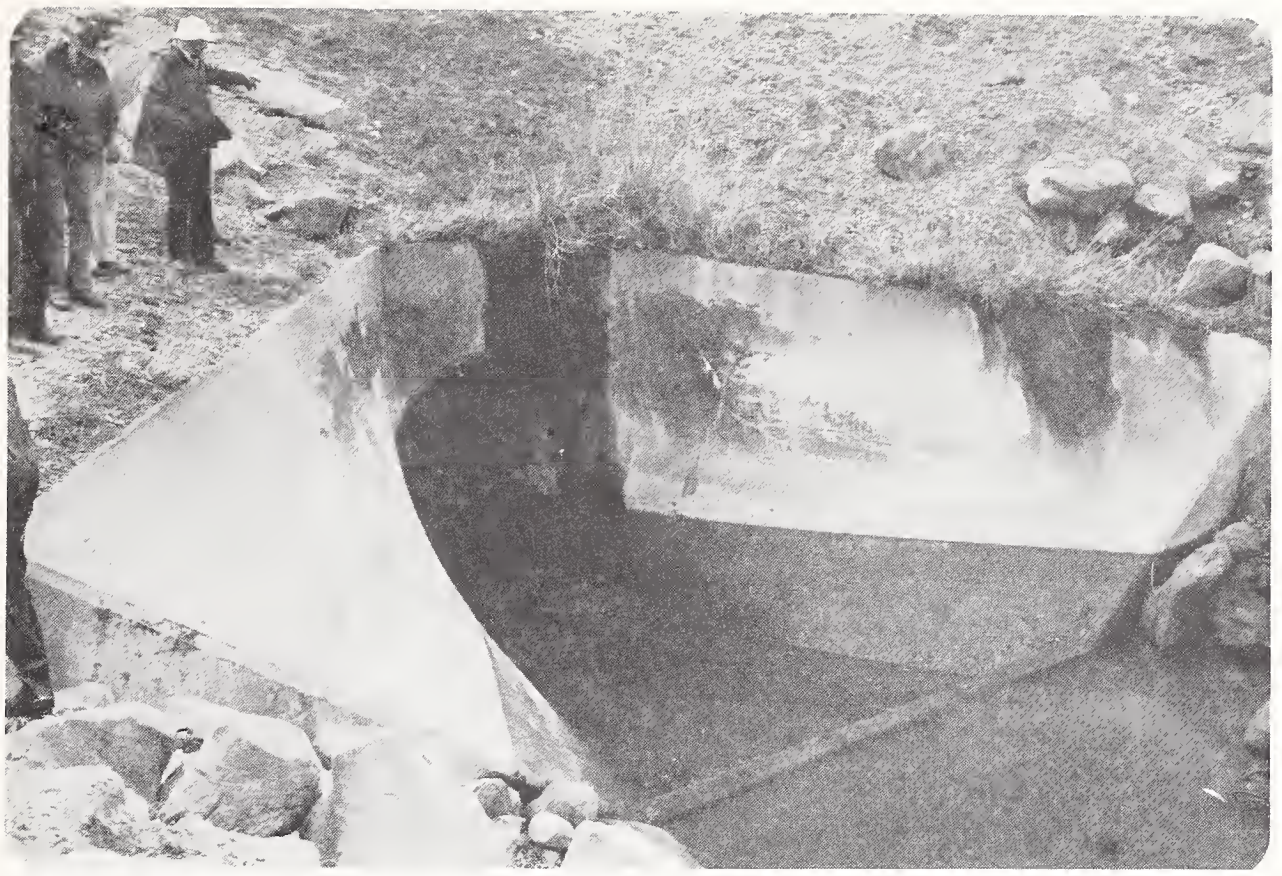
(PHOTO 4) Main Dam, Downstream Face, Maximum Section and Left Abutment Trough.

(PHOTO 5) Main Dam, Gatehouse.

(PHOTO 6) Main Dam, Typical Cracks in Conduit.



(PHOTO 7) Main Dam, Control Gates. Operating Gate Raised in Foreground, Emergency Gate Lowered in Background.



(PHOTO 8) Main Dam, Conduit Outlet.

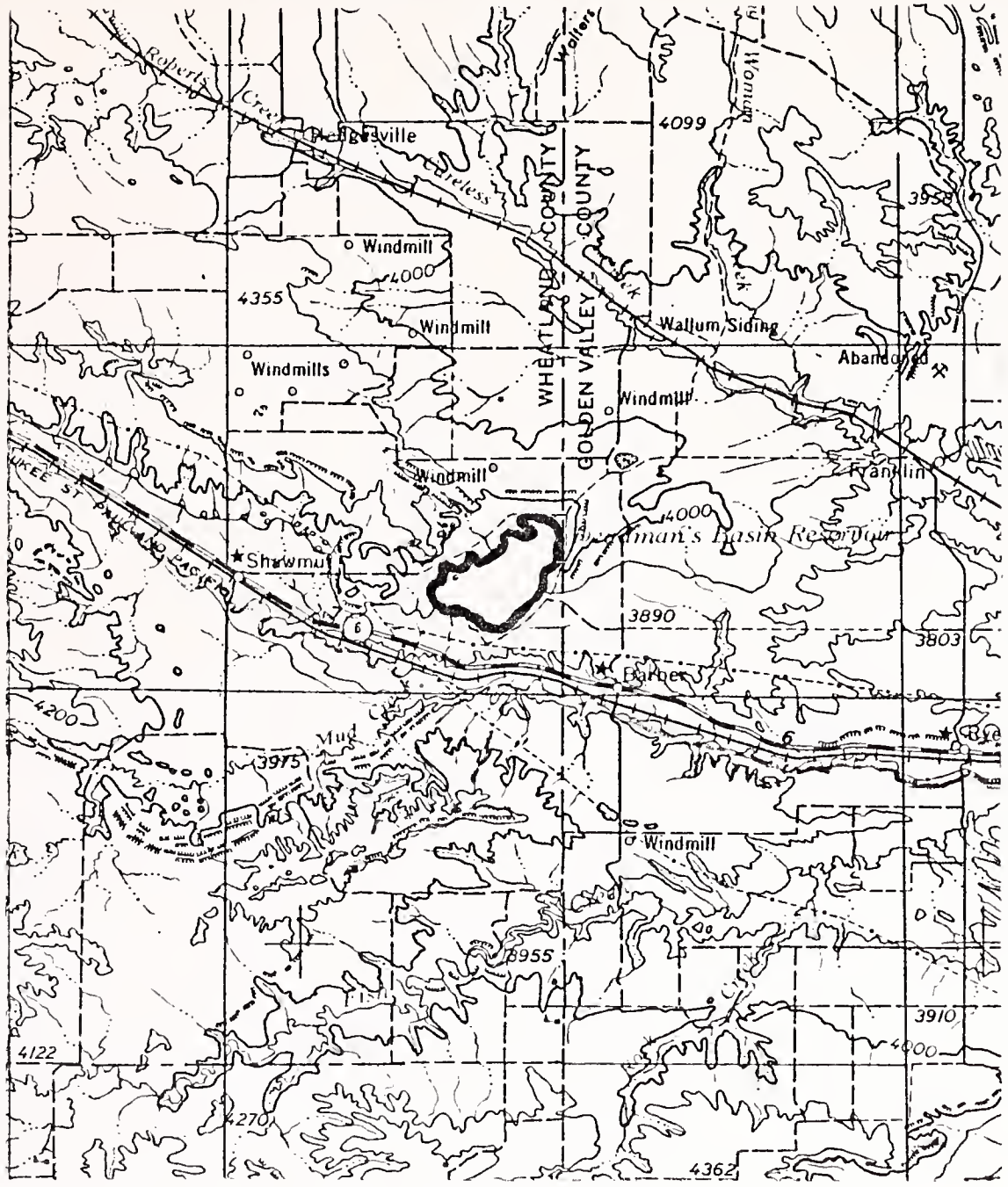
(PHOTO 9) Outlet Channel, Looking Downstream from Main Dam.

(PHOTO 10) Dike, Downstream Face from Right Abutment.

(PHOTO 11) Dike, Upstream Face from Right Abutment.

(PHOTO 12) Dike, Crest and Upstream Face from Left Abutment.

(PHOTO 13) Dike, Looking Downstream.

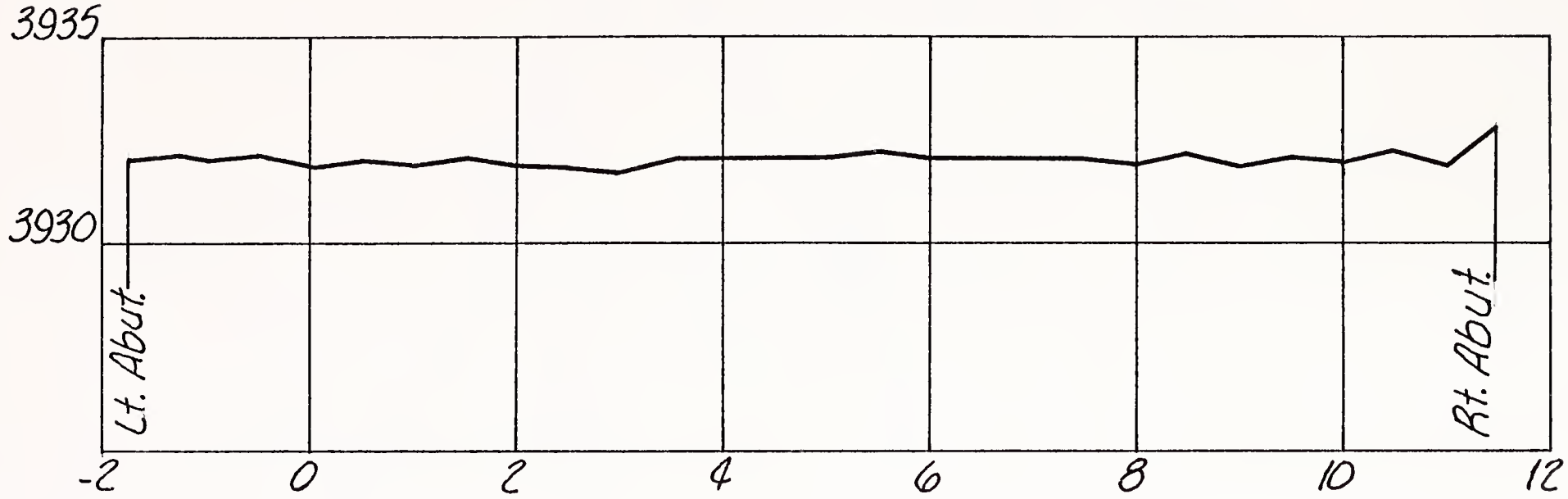


VICINITY MAP

SITE PLAN

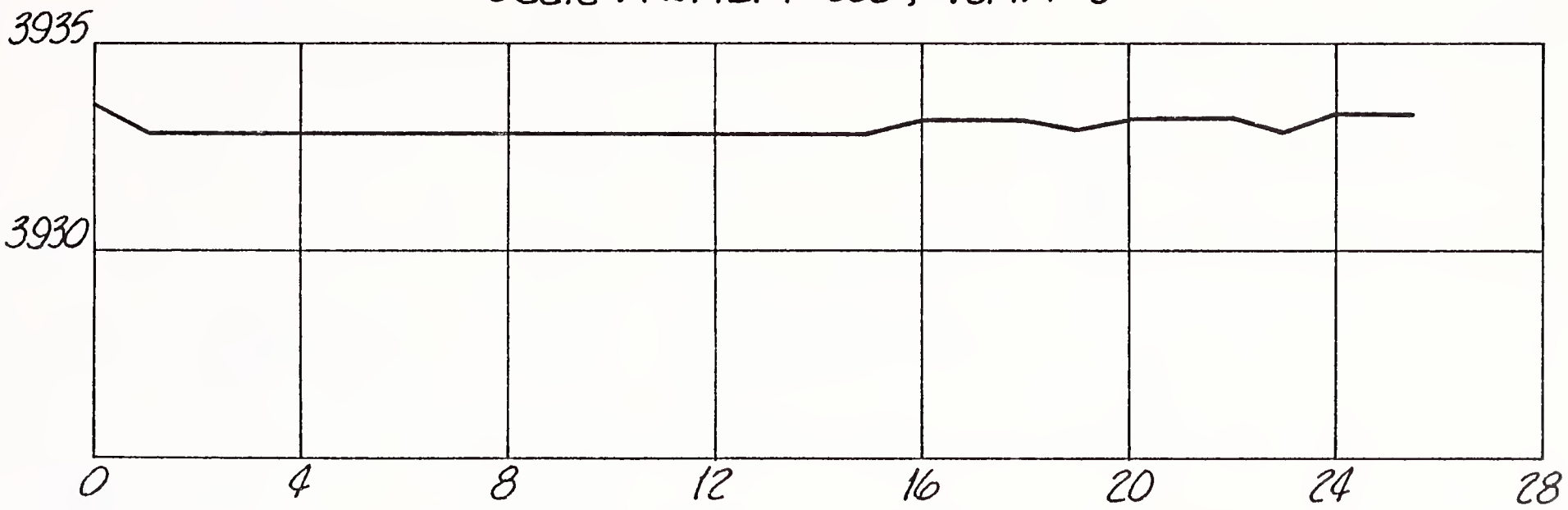
N

PLATE 1
DEADMANS BASIN RESERVOIR
SITE PLAN & VICINITY MAP



MAIN DAM CENTERLINE PROFILE

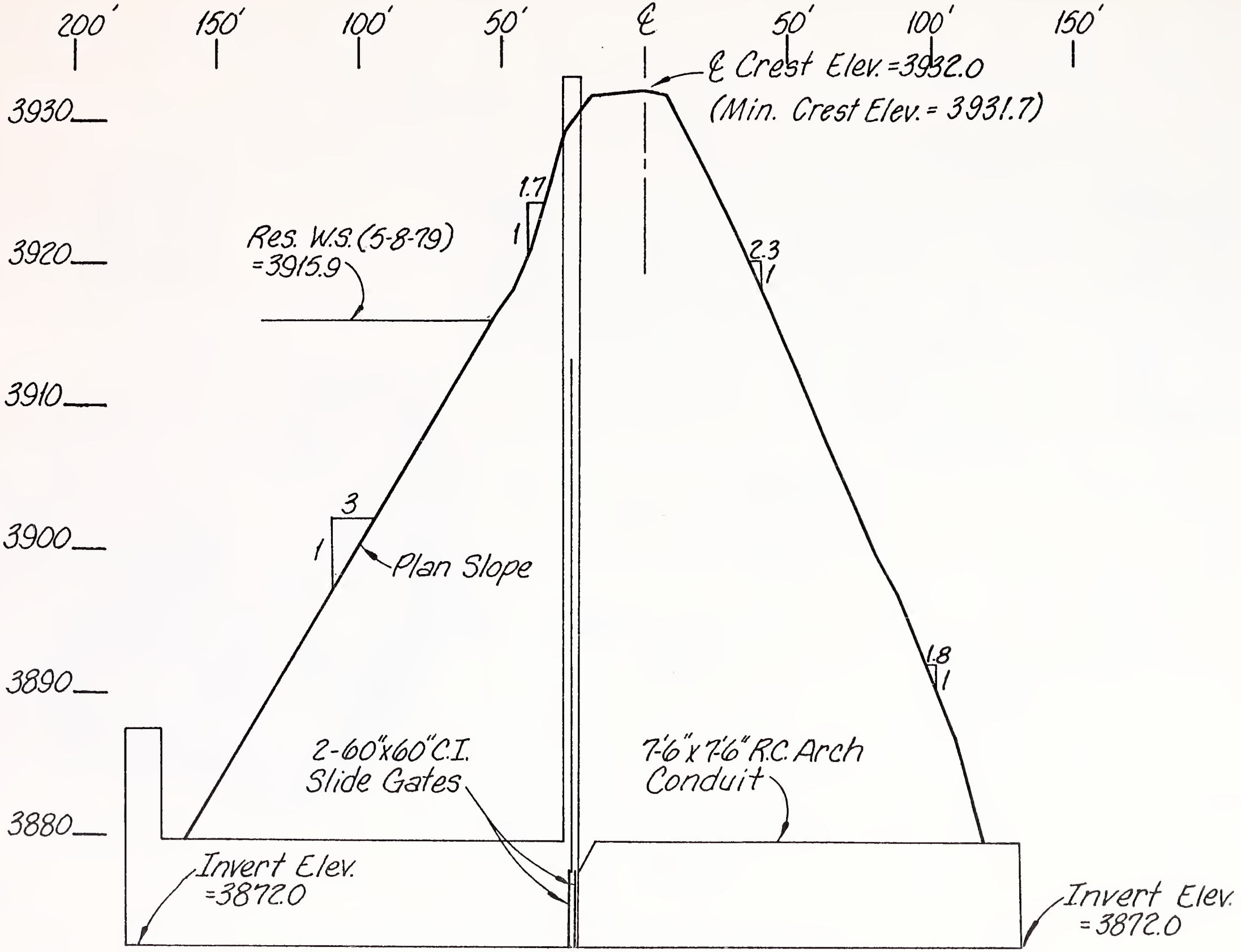
Scale : Horiz. 1"=200'; Vert. 1"=5'



DIKE CENTERLINE PROFILE

Scale : Horiz. 1"=400'; Vert. 1"=5'

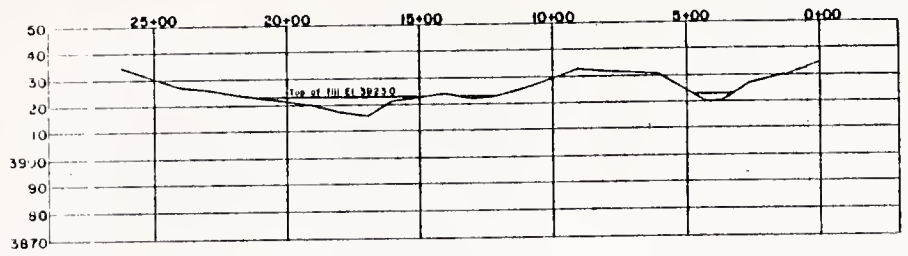
PLATE 2



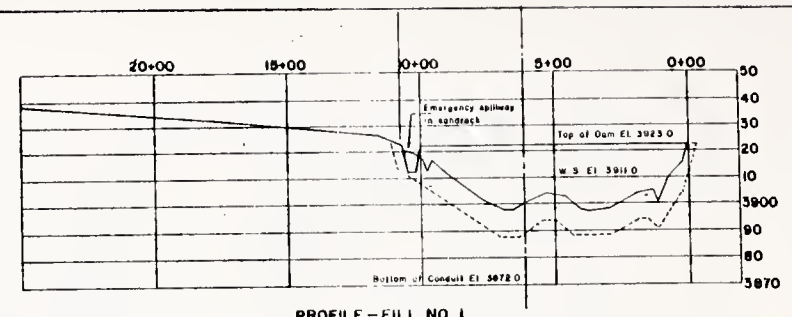
CROSS SECTION OF MAIN DAM - STA. 4+50

PLATE 3

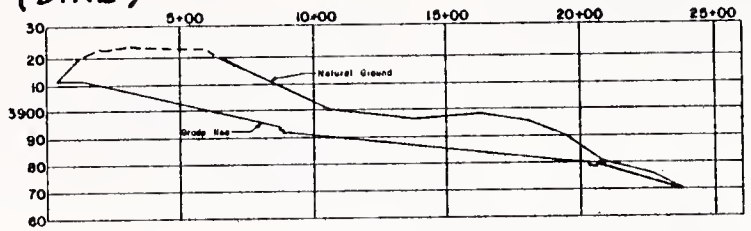
CONTOUR	AREA IN ACRES	STORAGE AC. FT.
3850	0	0
3872	618	4600
3875	785	6825
3880	995	11000
3885	1182	16500
3890	1337	22750
3895	1482	29750
3900	1817	37500
3905	1750	46000
3910	1878	55000
3911	1893	57000
3915	1961	68000
3918	2015	71250



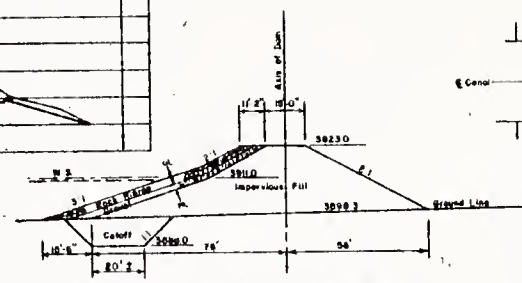
PROFILE—FILL NO. 2
Scale 1"=300' Hor.
1"=30' Ver
(DIKE)



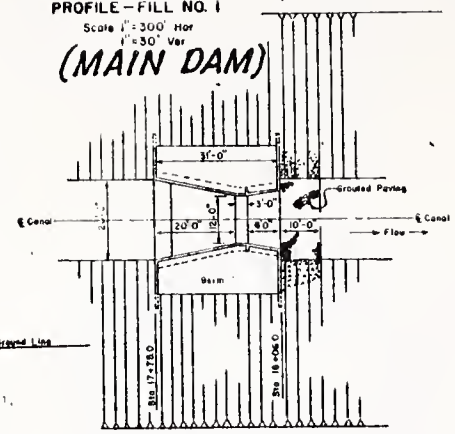
PROFILE—FILL NO. 1
Scale 1"=300' Hor
1"=30' Ver
(MAIN DAM)



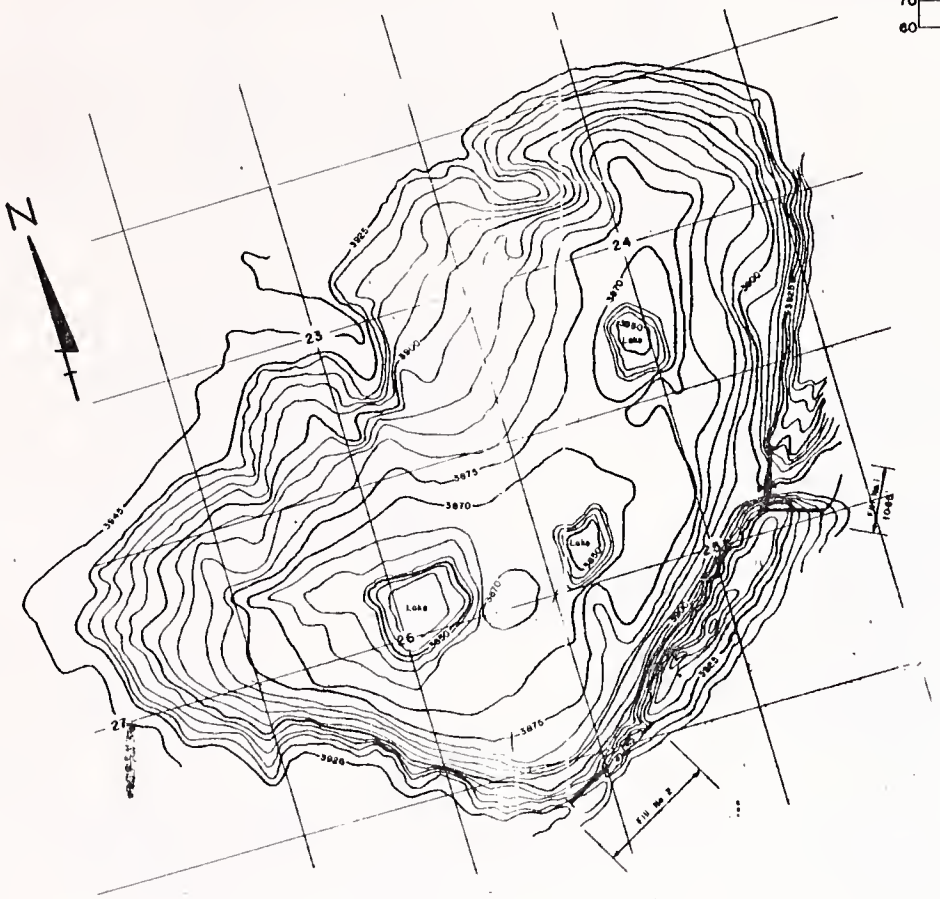
PROFILE OF SPILLWAY
Scale 1"=300' Hor
1"=30' Ver

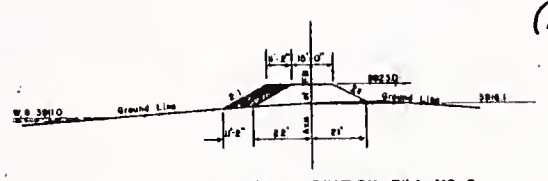


MAXIMUN TYPICAL SECTION—FILL NO. 1
Scale 1"=30'
(MAIN DAM)



MEASURING FLUME—PLAN
Scale 1"=20'





MAXIMUN TYPICAL SECTION—FILL NO. 2
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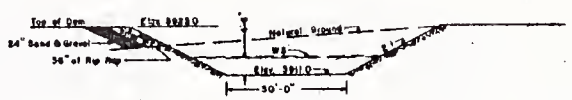
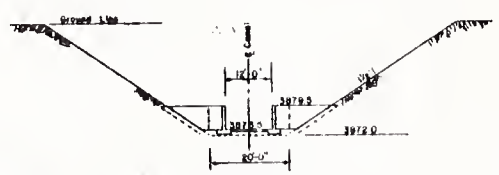
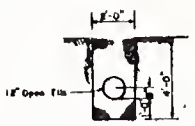
(DIKE)



SECTION THRU DAM
Scale 1"=20



SECTION THRU MEASURING FLUME
Scale 1"=20'



SECTION THRU DAM

TYPICAL CANAL SECTION
Scale 1"=20'

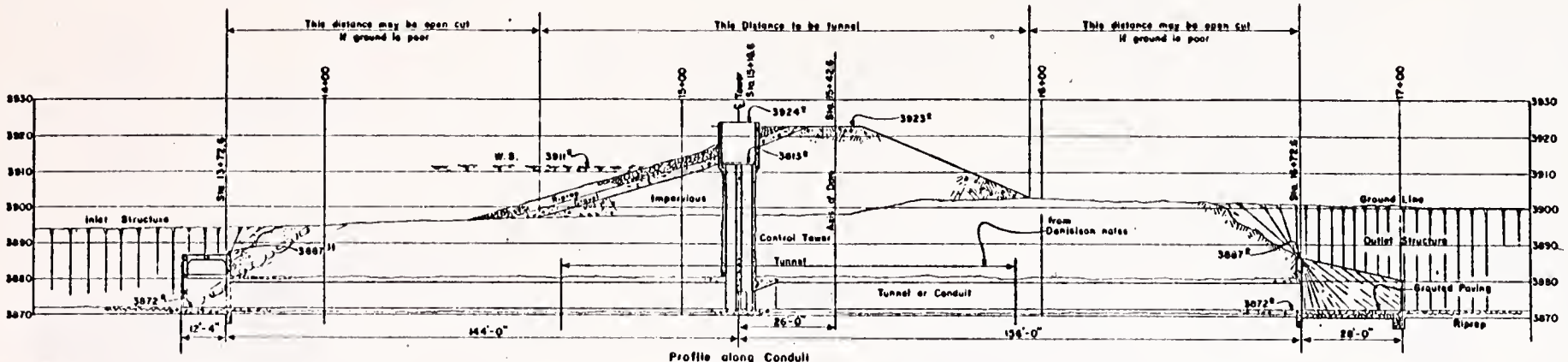
RESERVOIR MAP SHOWING
FILLS, MEASURING FLUME & DRAIN TRENCH

DEADMAN'S BASIN PROJECT
WHEATLAND COUNTY

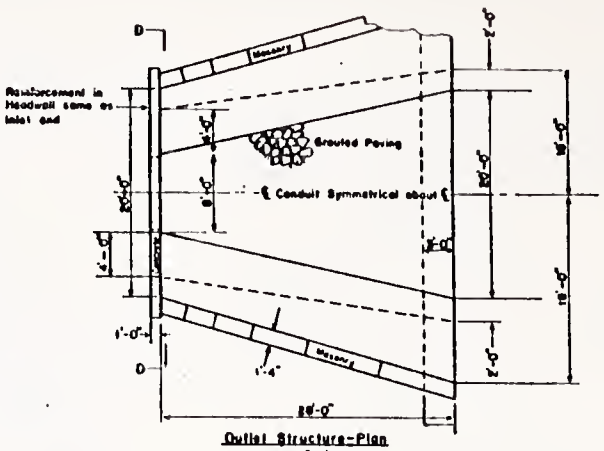
STATE WATER CONSERVATION BOARD

HELENA, MONTANA	MARCH, 1940
SCALE AS SHOWN	DRAWING NO. 92-10
Drawn P.K.W.	
Traced by G. Taylor June 1976	

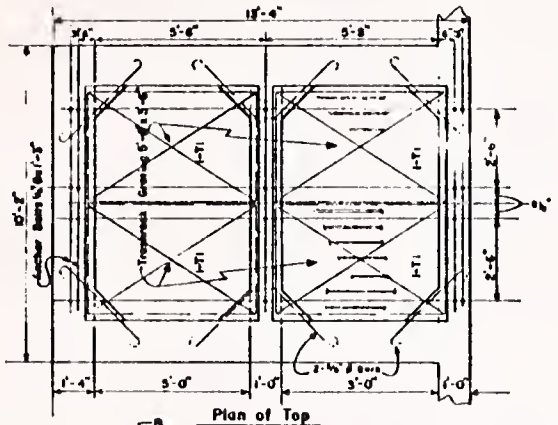
PLATE 4

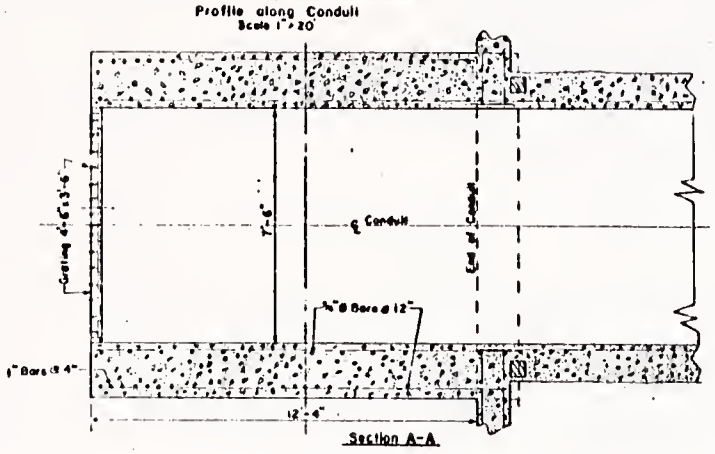


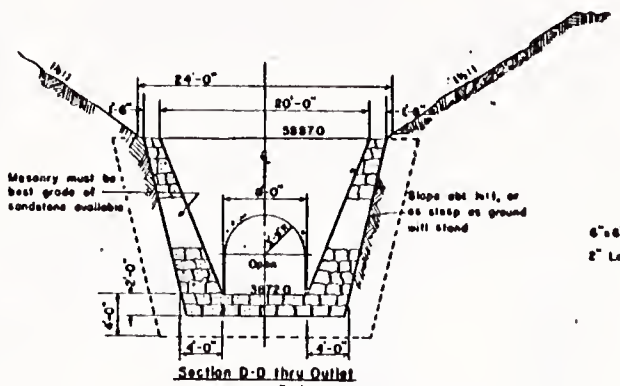
Profile along Conduit
Scale 1" = 20'

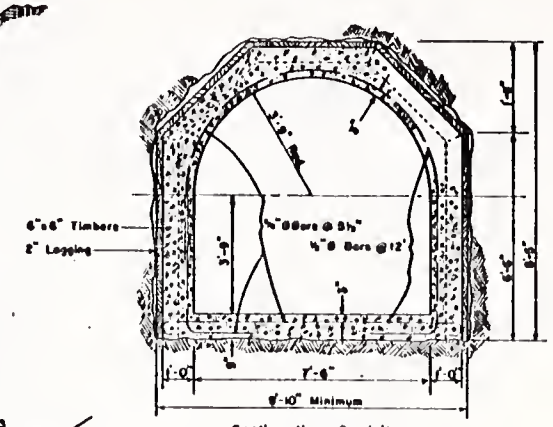


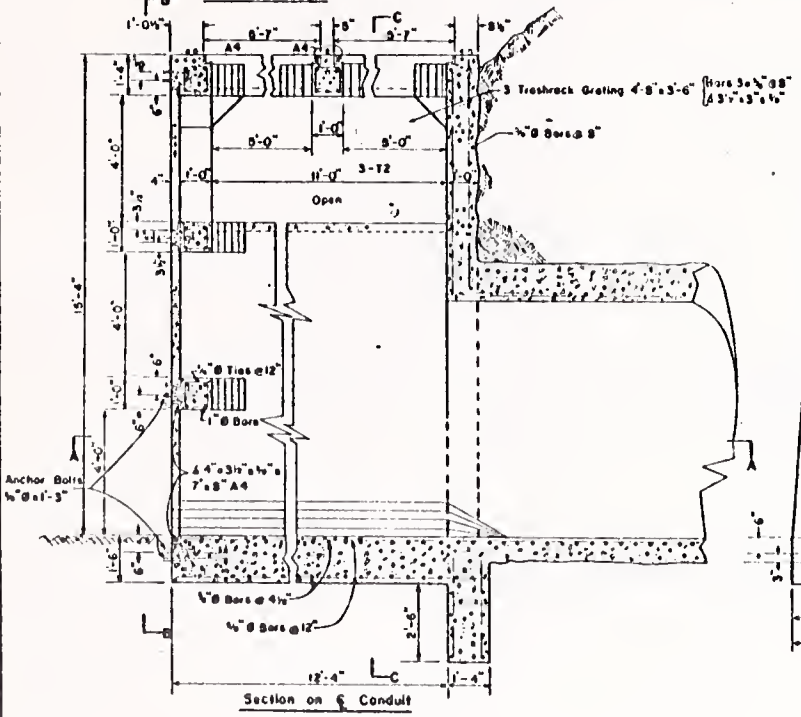
Outlet Structure-Plan
Scale ⅛"=1'

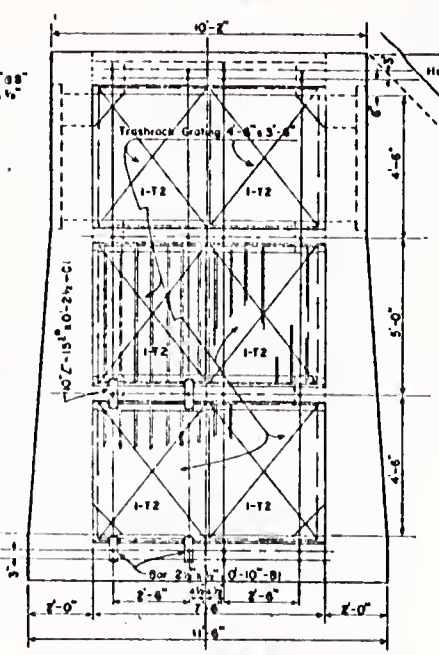


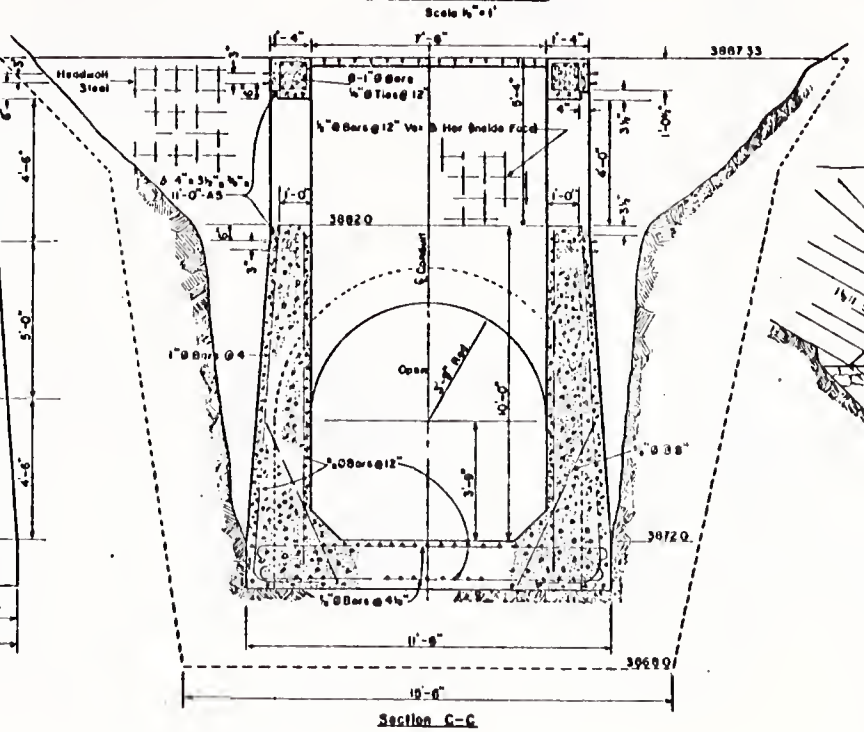


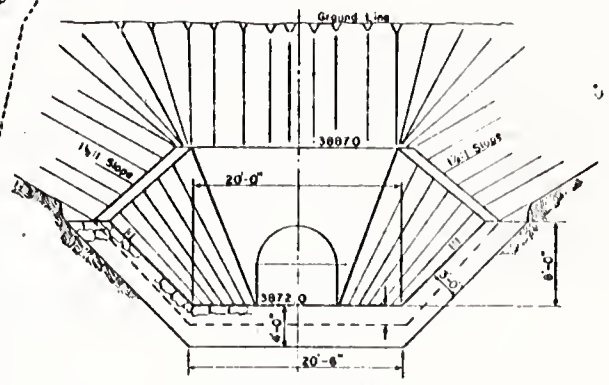

Masonry must be best grade of sandstone available
Slope abt hill, or as steep as ground will stand
Section D-D thru Outlet
Scale ⅛"=1'











INLET STRUCTURE DETAILS
Scale ⅛"=1'

See Drawing No 92-17 for details of T1, T2, A4, A5, B1 and C1

CONDUIT
INLET & OUTLET STRUCTURES

DEADMAN'S BASIN PROJECT

WHEATLAND COUNTY

HELENA, MONTANA — FEBRUARY, 1940

SCALE AS SHOWN — DRAWING NO. 92-16

Drawn by P.H.W.

Revised by A.C.H. 6/20/40

Traced by G. Taylor August 1978

PLATE 5

C1 and B1 are for inlet structure detailed on Dwg 92-16

DETAIL OF GATE THIMBLES
Scale ½"=1'-0"

T1, T2, A4 and A6 are for inlet structure details on dwg 92-16

The Gate Hoist shall be so designed that it will not require a force exerted on the crank of more than 75 lbs to start opening the gate under a static head of at least 50ft
Approximate high speed gear ratio 7.25:1
Approximate low speed gear ratio 32:1

Section D-D
Scale ½"=1'-0"

Section E-E

SECTION ON ℄ OF CONDUIT
Scale ¼"=1'-0"

NOTE: Gates may be subject to sealing pressures of a 50 ft static head.

Section A-A
Scale ¼"=1'-0"

Section B-B
Scale ¼"=1'-0"

Section C-C
Scale ¼"=1'-0"

LADDER DETAILS
Scale ½"=1'-0"

LADDER SUPPORT DETAILS
Scale 2"=1'-0"

CONTROL TOWER
WHEATLAND COUNTY

DEADMAN'S BASIN PROJECT

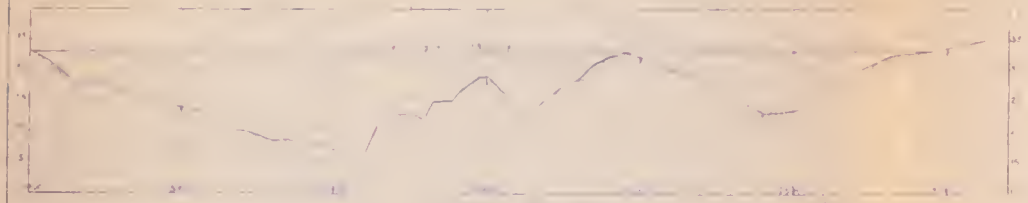
STATE WATER CONSERVATION BOARD
HELENA, MONTANA FEBRUARY, 1940
SCALE AS SHOWN
DRAWING NO. 92-17

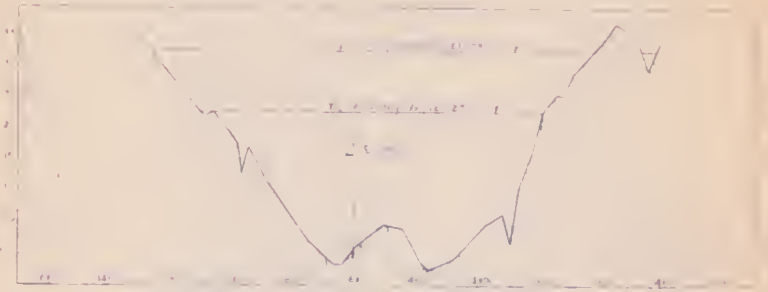
Drawn P K W	Revised 6/19/40 A C N
Revised 5/14/40 L. N	Traced by G Taylor July 1876

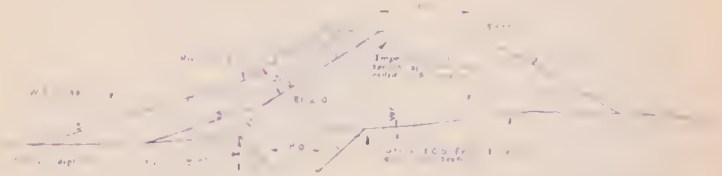
PLATE 6

SECTION THRU CONDUIT

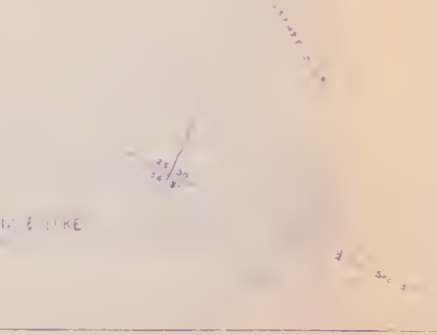
SECTION AT STA 6+6







TYPICAL SECTION DIKE



LOCATION OF DAM & DIKE

NOTE

THIS DRAWING SUPERSEDES DRAWING NO. 32 3R DATED OCT 1957

	J.C. 17 July 58

DETAILS FOR RADIAL GATE

DEADMANS BASIN PROJECT

GOLDEN VALLEY COUNTY

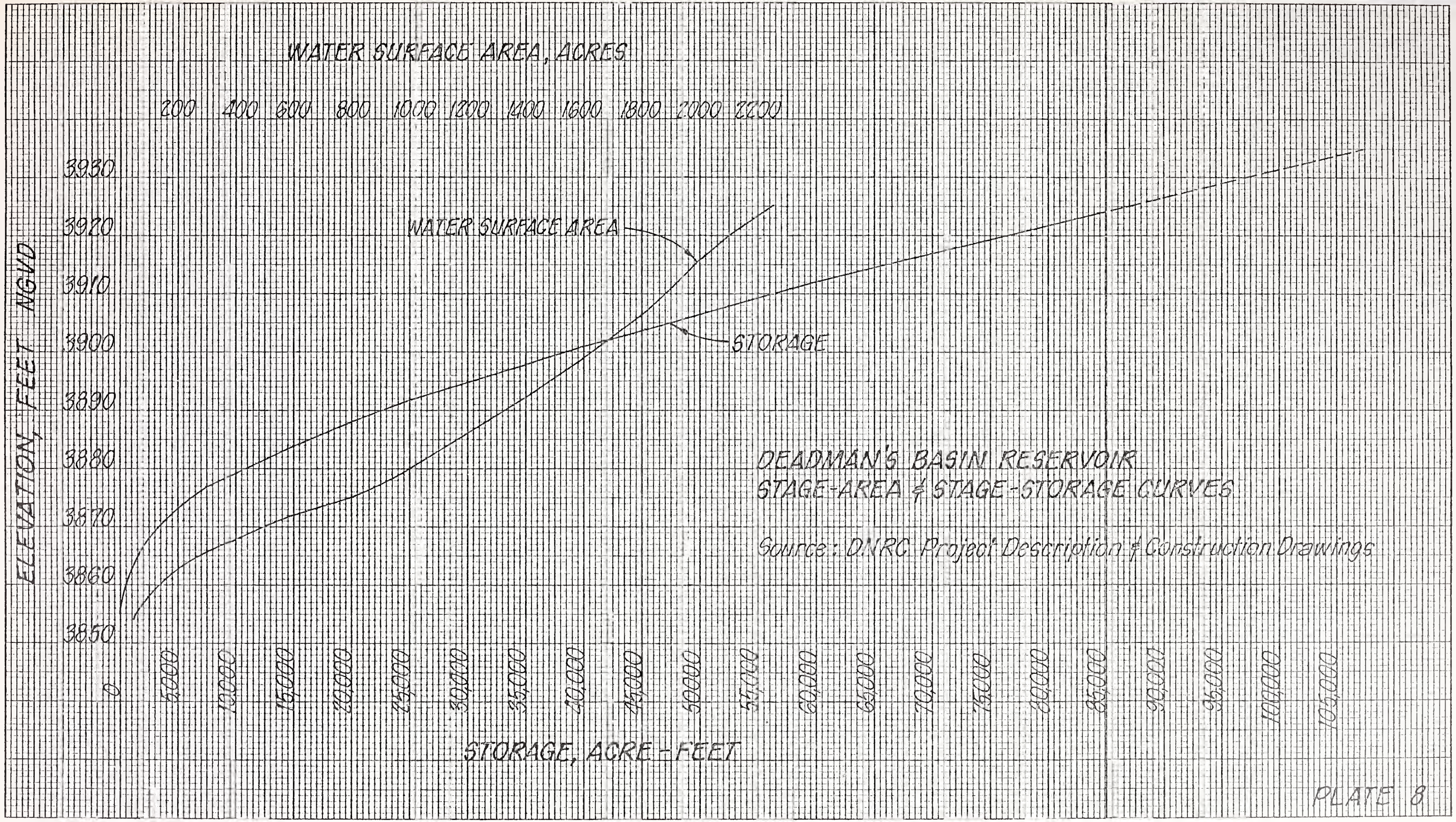
STATE WATER CONSERVATION BOARD

HELENA, MONTANA

SCALE AS SHOWN

DWG. NO. 32 3R

PLATE 7



DEADMAN'S BASIN RESERVOIR
STAGE-AREA & STAGE-STORAGE CURVES

Source: DNRC Project Description & Construction Drawings

PLATE 8

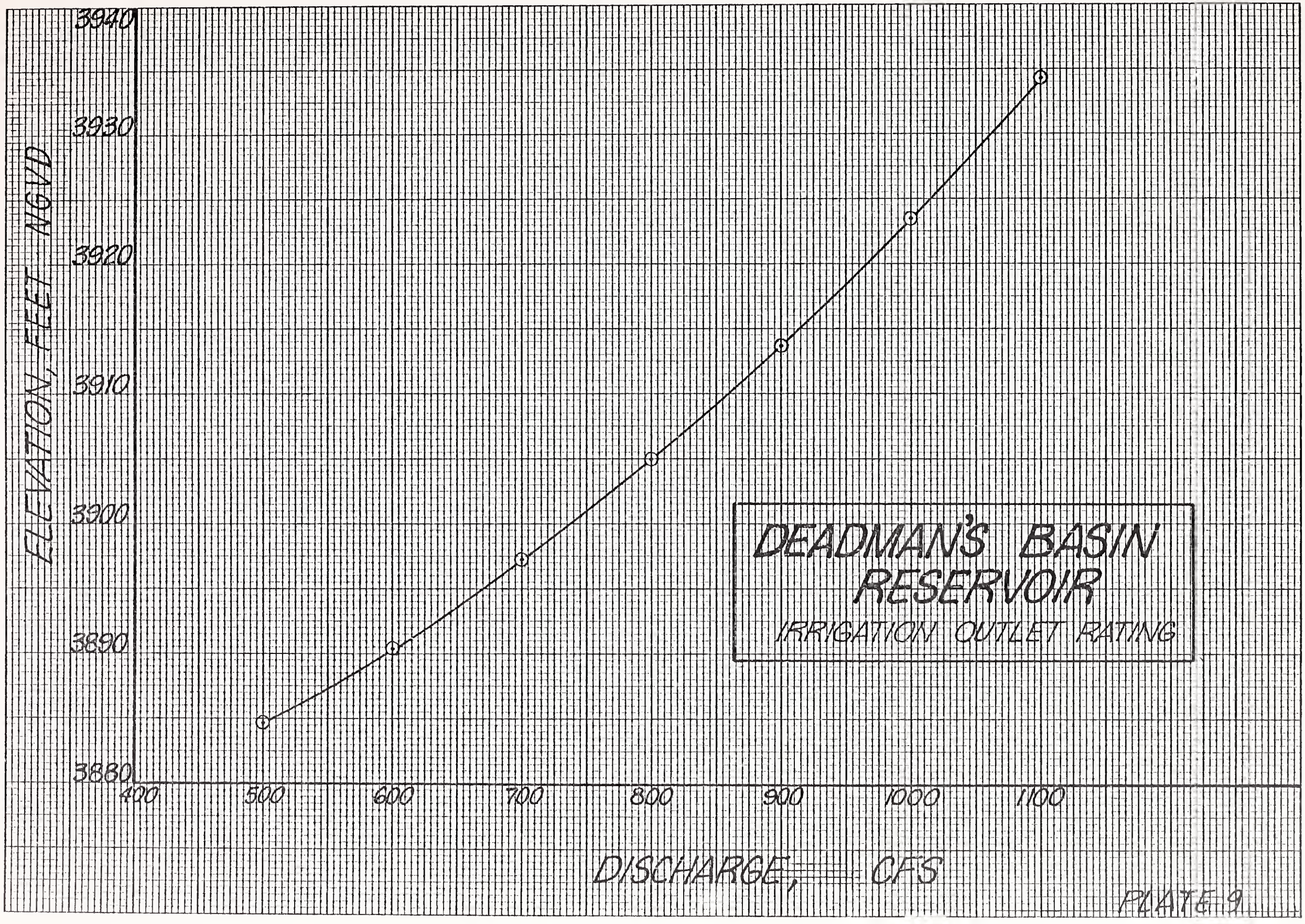

3940
3930
3920
3910
3900
3890
3880
ELEVATION, FEET ABOVE MSL
400
500
600
700
800
900
1000
1100
DISCHARGE, CFS
DEADMAN'S BASIN RESERVOIR
IRRIGATION OUTLET RATING

PLATE 9

APPENDIX A

BORING LOGS

DEADMAN'S BASIN DAM

JULY, 1967

(Boring locations specified by original
dam centerline stationing)

HOLE #1 7/20/67

5+50

0-2' gravel
28½' compact tan sandy clay, w/o ac.
thin intervals yellow sandy clay
28'11" green clay, soft, slightly sandy
29'7" caliche 2'-2½"
33'2" soft green clay, slightly sandy
~~34'5½"~~ lost
35'7½" slightly sandy clay
35'9½" gray and yellow sandstone
~~35'11½"~~ lost
36'5½" rotten water-wet sandstone

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEADMANS Project No. 92 State MONT. Hole No. 2

Location 6+30 Angle from Vert.

Feature SAMPLING- Coords. E N Surface El. Bearing of Angle

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOVERY (Feet)	PERCOLATION TESTS DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
0	40.5'	3"	BR. + YELLOW (CLAY) COMPACTED FILL						
40.5	42.5		BLUE & BROWN WET CLAY						
42.5'	43.		BROWN CLAY GRAVEL-						
43	44.5'		BROWN (CLAY) COMPACTED FILL						
44.5	44.5'		BED ROCK						

REMARKS: HOLE # 2 WAS DRY - @ 40.5" - ENCOUNTERED BLUE MUD 42.5' HIT BROWN COMPACTED FILL - 43' HIT SMALL GRAVEL - BED ROCK @ 44.6" -

Water level (start of shift) Water level (after bailing) Pump capacity (at swivel)

Water levels (other holes) Pipe left in hole (size and length)

Hole at (end of shift) Casing(s) at Shift: Date:

Bit data: Nx #___ft.___: Bx#___ft.___: Ax #___ft.___: Driller Hole No. 2

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEAD MAN'S Project No. 92 State MONT Hole No. 3

Location 1+30 Angle from Vert.

Feature SAMPLING Coords. E N Surface El. Bearing of Angle

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOVERY (Feet)	PERCOLATION TESTS DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
14.10	24.10		DRY COMPACTED FILL						
24.10	33.7		DRILLED - DRY COMPACTED FILL						
33.7	34.7		DRILLED - BR. CLAY - WET						
34.7	40.5'		DRY COMPACTED FILL						
40.5	40.7		YELLOW SAND WET -						

REMARKS:

WATER up 19.5' - 4 DAY LATER

Water level (start of shift) (27') Water level (after bailing) Pump capacity (at swivel)

Water levels (other holes) Pipe left in hole (size and length)

Hole at (end of shift) Casing(s) at Shift: Date:

Bit data: Nx #____ft.____: Bx#____ft.____: Ax #____ft.____: Driller Hole No. 3

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEADMAN'S Project No. 92 State MONT Hole No. 4

Feature DRILL + SAMPLE Location 4 + 50 Angle from Vert.

Coords. E N Surface El. Bearing of Angle

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOV-ERY (Feet)	PERCOLATION TESTS DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
0	1	3"	GRAVEL						
1	22	3"	DRY COMPACTED FILL -						
22	29	"	" " " " "						
29	33	"	SAND STONE - YELLOW - WET. @ 33'						

REMARKS:

Water level (start of shift) Water level (after bailing) Pump capacity (at swivel)

Water levels (other holes) Pipe left in hole (size and length)

Hole at (end of shift) Casing(s) at Shift: Date:

Bit data: Nx #____ft.____: Bx#____ft.____: Ax #____ft.____: Driller Hole No. 4

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEADWOOD Project No. 92 State MONT Hole No. 5-

Location 3+00 Angle from Vert.

Feature DRILL - SAMPLE - Coords. E N Surface El. Bearing of Angle

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOVERY (Feet)	PERCOLATION TESTS DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
0	1		GRAVEL						
1	22.5'		DRY COMPACTED FILL.						
22.5'	23.00		BOULDER						
23.00	23.5		CLAY YELLOW - BROWN						
23.5'	25'		BOULDER - DRY						
25	34		SANDSTONE - YELLOW - WATER @ 34' -						
34	40		SHALE - GREY - YELLOW - VIRGIN MATERIAL						

REMARKS: DRILLED FROM 0 TO 34 - SAMPLED FROM 34 TO 40.2 -

Water level (start of shift) Water level (after bailing) Pump capacity (at swivel)

Water levels (other holes) Pipe left in hole (size and length)

Hole at (end of shift) Casing(s) at Shift: Date:

Bit data: Nx #____ft.____: Bx#____ft.____: Ax #____ft.____: Driller Hole No. 5-

50' NORTH OF #1

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEAD MANS- Project No. # 92 State MONT Hole No. 6

Location BETWEEN 4 AND 1- Angle from Ve

Feature DRILL + SAMPLEING Coords. E N Surface El. Bearing of A

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOV-ERY (Feet)	PERCOLATIO		ESTS		
					DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
0	1		GRAVEL-						
1	26.5'		DRY COMPACTED FILL-						
26.5'	33		SANDSTONE - YELLOW-						

REMARKS: WATER @ 33'- WATER LEVEL 20' FROM G.L. 20 MIN AFTER COMPLETED HOLE-

Water level (start of shift) Water level (after bailing) Pump capacity (at swivel

Water levels (other holes) Pipe left in hole (size and length

Hole at (end of shift) Casing(s) at Shift: Date: 7-5 67

Bit data: Nx #___ft.___: Bx#___ft.___: Ax #___ft.___: Driller Hole No. 6

50' SOUTH OF #2

STATE WATER CONSERVATION BOARD

DAILY DRILL REPORT

Project DEADMANS Project No. 92 State MONT Hole No. 7

Location 6+80 Angle from Vert.

Feature DRILL + SAMPLE Coords. E N Surface El. Bearing of Angle

DEPTH FROM	DEPTH TO	SIZE & TYPE		RECOVERY (Feet)	PERCOLATION TESTS DEPTH Seal	DEPTH Hole	LOSS (1)	PSI (2)	TIME (3)
0	½		GRAVEL						
½"	18½		DRY COMPACTED FILL -						
18½	19		BOULDER						
19	22		DRY COMPACTED FILL						
22	31.6		SANDST. - YELLOW -						
31.6	39.2		CLAY - BR YELLOW - SMALL SANDSTONE -						
39.2	39.8		" " " "						
39.8	40.10		" " " "						
41.10	42.6		SOFT SANDY SILT - WET						

REMARKS: HIT WATER @ 41.10 - DRILLED FROM 0 TO 31.6 - SAMPLED FROM 31.6 TO 38.2 - REAMED AND DRILLED 38.2 TO 39.2 - SAMPLED FROM 39.2 TO 42.6 -

Water level (start of shift) Water level (after bailing) Pump capacity (at swivel)

Water levels (other holes) Pipe left in hole (size and length)

Hole at (end of shift) Casing(s) at Shift: Date: 7-5-67

Bit data: Nx # ft. : Bx# ft. : Ax # ft. : Driller Hole No. 7

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872

HELENA, MONTANA 59601

February 4, 1981

Ralph Morrison
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Morrison:

The Department of Natural Resources and Conservation has reviewed the final draft report on the Deadman's Basin Dam (MT-11). We concur with the findings and recommendations in the report and feel that the report satisfies the criteria for the Phase I investigation. Our comments have been discussed with your staff and we understand that they will be incorporated into the final report.

We sent copies of the final draft report to the Deadman's Basin Water Users Association for their review and comments. They chose not to make a formal submittal of their comments.

Thank you for the opportunity to review and comment on the final draft report for this project.

Sincerely,

Richard L. Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
(406) 449-2864

RB:LT:lj

"AN EQUAL OPPORTUNITY EMPLOYER"